

WHAT IS CLAIMED IS:

1. A method of manufacturing an interconnect structure,  
comprising:

forming a nucleation layer including a first metal over a  
barrier layer and within an opening formed in a dielectric layer;

forming an intermediate layer including a second metal over  
the nucleation layer and within the opening; and

forming a plug portion layer including the first metal over  
the intermediate layer and within the opening.

2. The method as recited in Claim 1 wherein forming a  
nucleation layer including a first metal includes forming a  
nucleation layer including a first metal comprising tungsten.

3. The method as recited in Claim 2 wherein forming a  
nucleation layer including a first metal comprising tungsten  
includes forming a nucleation layer including a first metal  
comprising tungsten with a gas mixture of tungsten hexafluoride and  
silane.

4. The method as recited in Claim 2 wherein forming a  
nucleation layer including a first metal comprising tungsten

3 includes forming a plug portion layer including a first metal  
4 comprising tungsten.

5. The method as recited in Claim 1 wherein forming an  
2 intermediate layer including a second metal includes forming an  
3 intermediate layer including a second metal comprising titanium  
4 nitride.

6. The method as recited in Claim 1 further including  
forming an adhesion layer comprising titanium prior to forming the  
barrier layer and forming the barrier layer includes forming a  
titanium nitride barrier layer.

7. The method as recited in Claim 1 wherein forming the  
intermediate layer includes forming the intermediate layer to a  
thickness of less than about 20 nm.

8. The method as recited in Claim 1 wherein forming the  
2 nucleation layer includes forming the nucleation layer to a  
3 thickness that ranges from about 20 nm to 200 nm.

9. The method as recited in Claim 1 wherein forming the  
2 nucleation layer, forming the intermediate layer and forming the

3 plug portion layer includes forming the nucleation layer, the  
4 intermediate layer and the plug portion layer in a single multi-  
5 chamber tool.

10. The method as recited in Claim 1 wherein forming the  
2 nucleation layer, forming the intermediate layer and forming the  
3 plug portion layer includes forming the nucleation layer, the  
4 intermediate layer and the plug portion layer with a plasma  
5 enhanced chemical vapor deposition process.

11. The method as recited in Claim 1 wherein forming the  
2 nucleation layer and the plug portion layer includes forming the  
3 nucleation layer and the plug portion layer such that an average  
4 grain size of the nucleation layer is substantially a same size as  
5 an average grain size of the plug portion layer.

12. The method as recited in Claim 1 wherein forming the  
2 intermediate layer and forming the nucleation layers includes  
3 forming a plurality of alternating intermediate layers and  
4 nucleation layers.

13. A method of manufacturing an integrated circuit,  
2 comprising:

3 forming active or passive devices over a semiconductor wafer  
4 substrate;

5 forming a dielectric layer over the active or passive devices;  
6 and

7 forming interconnect structures in the dielectric layer to  
8 interconnect the active or passive devices to form an operative  
9 integrated circuit, including:

10 forming a nucleation layer including a first metal over  
11 a barrier layer and within an opening formed in a dielectric layer;

12 forming an intermediate layer including a second metal  
13 over the nucleation layer and within the opening; and

14 forming a plug portion layer including the first metal  
15 over the intermediate layer and within the opening.

14. The method as recited in Claim 13 wherein forming a  
2 nucleation layer including a first metal includes forming a  
3 nucleation layer including a first metal comprising tungsten.

15. The method as recited in Claim 14 wherein forming a  
2 nucleation layer including a first metal comprising tungsten  
3 includes forming a nucleation layer including a first metal

4 comprising tungsten with a gas mixture of tungsten hexafluoride and  
5 silane.

16. The method as recited in Claim 14 wherein forming a  
2 nucleation layer including a first metal comprising tungsten  
3 includes forming a plug portion layer including a first metal  
4 comprising tungsten.

17. The method as recited in Claim 13 wherein forming an  
2 intermediate layer including a second metal includes forming an  
3 intermediate layer including a second metal comprising titanium  
4 nitride.

18. The method as recited in Claim 13 further including  
forming an adhesion layer comprising titanium prior to forming the  
barrier layer and forming the barrier layer includes forming a  
4 titanium nitride barrier layer.

19. The method as recited in Claim 13 wherein forming the  
2 intermediate layer includes forming the intermediate layer to a  
3 thickness of less than about 20 nm.

20. The method as recited in Claim 13 wherein forming the

nucleation layer includes forming the nucleation layer to a thickness that ranges from about 20 nm to 200 nm.

21. The method as recited in Claim 13 wherein forming the nucleation layer, forming the intermediate layer and forming the plug portion layer includes forming the nucleation layer, the intermediate layer and the plug portion layer in a single multi-chamber tool.

22. The method as recited in Claim 13 wherein forming the nucleation layer, forming the intermediate layer and forming the plug portion layer includes forming the nucleation layer, the intermediate layer and the plug portion layer with a plasma enhanced chemical vapor deposition process.

23. The method as recited in Claim 13 wherein forming the nucleation layer and the plug portion layer includes forming the nucleation layer and the plug portion layer such that an average grain size of the nucleation layer is substantially a same size as an average grain size of the plug portion layer.

24. The method as recited in Claim 13 wherein forming the intermediate layer and forming the nucleation layers includes



25. An interconnect structure, comprising:

2 a nucleation layer including a first metal located over a  
3 barrier layer within an opening in a dielectric layer;

4 an intermediate layer including a second metal located over  
5 the nucleation layer; and

6 a bulk plug layer including the first metal located over the  
7 intermediate layer.

26. The interconnect structure as recited in Claim 25 wherein  
2 the first metal comprises tungsten.

27. The interconnect structure as recited in Claim 26 wherein  
2 the plug portion layer comprises tungsten

28. The interconnect structure as recited in Claim 25 wherein  
3 the intermediate layer comprises titanium nitride.

29. The interconnect structure as recited in Claim 25 further  
2 including an adhesion layer comprising titanium located under a  
3 barrier layer comprising titanium nitride.

30. The interconnect structure as recited in Claim 25 wherein  
2 the intermediate layer has a thickness of less than about 20 nm.



